THE RESTORATION OF VITALITY TO MUSCLES WHICH HAVE BEEN COMPLETELY PARALYZED FROM POLIO-MYELITIS.

By GRÆME M. HAMMOND, M D.,
New York.

IT has always been a question of considerable doubt as to whether electrical stimulation of muscles which have become paralyzed from disease of the spinal cord has any decided influence in restoring them to a normal condition and at the same time reflexly stimulating degenerated nerve cells in the cord into a condition of vitality. I think it may be taken for granted that if any permanent benefit is derived from electrical stimulation of the muscles, it must be in consequence of aroused energy in the nerve cells which supply those muscles. Stimulation confined entirely to the muscular tissue, if it has any regenerative effect at all, can only be temporary, and must cease to be operative soon after the stimulation is discontinued. To be permanent at all, the cells in the anterior horns must be stimulated or developed sufficiently to enable them, by their own activity, to supply the paralyzed muscles with motion and nutrition. I do not refer to acute diseases of the cord. In such cases a certain amount of repair takes place in the cord after the destructive process has ceased; but while the disease is in progress the paralyzed muscles are undergoing atrophy, which degenerative local applications of electricity can retard to a great extent. I refer particularly to chronic cases, in which the destructive process in the cord has long since ceased and in which the patient is left with some muscles over which there is slight voluntary control, and with others which seem to be totally paralyzed.

Microscopical examinations of sections of the spinal cord in such instances shows the affected anterior horn to be atrophied, while many of the nerve cells have entirely disappeared; and others, again, have become rounded, have lost many of their processes, their nuclei are indistinct, and the body of the cell is shrunken, pigmented, or granular. Cells are observed in all stages of degeneration, from almost total destruction to a nearly normal condition.

It is the general opinion, and it is probably correct, that the paralysis and atrophy of the muscles are in direct ratio to the destruction of the cells in the anterior horns; that muscles which are partially paralyzed are supplied by cells in a more or less partial state of degeneration; and that these muscles, of which the patient has absolutely lost all motor power, have reached that condition on account of the total destruction of the cells which formerly enervated them.

There is a wide diversity of opinion in regard to the value of electricity in the treatment of the paralysis of spinal origin. Nearly all investigators admit the efficacy of this agent, in acute cases of polio-myelitis, in retarding the paralysis and atrophy of the affected muscles, simply by its local stimulating action on the muscles themselves. But there is not the same unanimity of opinion when the chronic form of polio-myelitis is considered. As I have previously remarked, the only way in which voluntary movements of the paralyzed muscles can be regained is by the more or less complete regeneration of the nerve cells in the anterior horns. No one for a moment believes that nerve cells which have been entirely obliterated can be reproduced again by the action of electricity or by anything else, and many refuse to believe that nerve cells which still exist, though in a more or less degenerated condition, can be stimulated to a more healthy growth or to any further development by electrical applications applied to the muscles supplied by such cells. It is quite possible, in some instances, even in apparently favorable cases, that electrical applications are unavailing; but the cases reported in which permanent benefit has been derived are too numerous to be disregarded. I shall not, therefore, consider the question of the efficacy of electricity in the treatment of chronic polio-myelitis: I shall take that for granted. I do not mean to say that I believe all cases can be benefited, but I believe many of them can be if properly treated. The subject which I shall call particular attention to is in reference to the ability to discriminate between those muscles which are capable of being improved and those which are too degenerated to admit of such a possibility.

It is generally conceded that muscles which do not respond at all to repeated attempts at electrical excitation are those whose cells have been destroyed. It is therefore useless to hope for any improvement in their condition. I will admit that if there is no contraction of the muscular elements, or if there are no muscular elements remaining, then electricity is a useless remedy. But how is it to be determined whether a muscle contracts or not? This question is usually decided by the senses of touch and sight. If the operator cannot feel a muscle contract or see it contract, he usually comes to the conclusion that it does not contract, and consequently gives a hopeless prognosis so far as that particular muscle is concerned. But there may be cases—I am satisfied there are such cases—in which the nerve cells, though greatly degenerated, are not entirely destroyed, and the muscular contraction under electrical stimulation does take place, though it may be so slight as to escape detection by the senses of the most acute observer; furthermore, that such cases are sometimes capable of a certain amount of improvement. In support of this view, I desire to report the following cases:

CASE I.—A lady, about twenty-five years of age, consulted me in the year 1889. When six months old she had suffered from an attack of anterior polio-myelitis, which left her with the anterior tibial and peroneal groups of muscles paralyzed in both legs. As she grew older, both gastrocnemii contracted, giving rise to marked talipes equinus. On examination, I found that all of the muscles in the right leg responded to the galvanic current, but not to the faradic. The contractions were, however, very slight. In the left leg the peroneal muscles responded very slightly to galvanism—the anterior tibial muscles not at all. The contraction of the gastrocnemii was so powerful that they could not be overcome by any force it would have been proper to have used. At my request Dr. A. M. Phelps divided the tendons of both muscles. After the tendons had reunited, it was found that the feet could be flexed passively to their normal limit. Voluntarily the patient could flex the right foot and extend the toes slightly. On the left side all of the muscles responded faintly to will power except the tibialis anticus and the extensor proprius pollicis. These muscles seemed to be completely paralyzed, nor would they respond to any form of electrical stimulation. My opinion was that those muscles which could be made to react to electricity could be developed to a limited degree, while it was hopeless to look for any improvement in the tibialis anticus and extensor proprius pollicis in the left leg. I made applications of galvanism almost daily for over a year. The applications were made to the two completely paralyzed muscles just as regularly and as thoroughly as they were made to the others. The development of the others was slow, but progressive. The power of flexion of the right foot gradually increased until it could be perfectly accomplished. I was greatly surprised, about six months after treatment began, to observe a very faint reaction in the left tibialis anticus. As time went on the contractions became more noticeable, and finally could be induced by efforts of the will. A year after treatment began, flexion of the left foot could be performed fairly well. A little over a year after treatment began, slight contractions were observed in the extensor proprius pollicis. This muscle has slowly developed, but not to the same extent as the tibialis anticus. The great toe can be partially extended, but the muscle is very weak. At the present time the patient walks quite well without a brace of any kind. The heel strikes the ground first, and in bringing the feet forward they can both be so well flexed that the toes never strike the ground.

CASE II.—A lad, eleven years of age, consulted me in April, 1891. When he was six years of age he had an attack of unilateral polio-myelitis, which resulted in partial paralysis of the anterior tibial group of the left leg, with the exception of the tibialis anticus, which was totally paralyzed. The peroneal group were in the same condition. These muscles could not be made to contract to the electrical current to the slightest appreciable extent. All other muscles acted feebly. There was slight talipes equino-varus. The gastrocnemius was contracted and unyielding; so the tendon was cut.

Electricity was used daily, all of the muscles reacting except the peroneals and tibialis anticus. These muscles, however, received applications just the same as the others. It was only after seven months of daily applications that faint contractions were observed in the tibialis anticus. These, however, increased in vigor, and soon slight contractions could be induced by efforts of the will. This muscle has slowly developed power, so that the foot can be voluntarily flexed; but it requires a mental effort to perform the act, and the muscular effort cannot yet be maintained longer than a few seconds. Although I persistently endeavored, for a year and a half, to arouse some vitality in the peroneal muscles, I was not successful. The muscles are just as inert to-day as they were when I first examined them.

CASE III.—A boy, nine years old, came to my clinic at the Post-Graduate Hospital, in May, 1891. When he was three years of age he had had an attack of anterior polio-myelitis, which had paralyzed the muscles on the anterior and external sides of the leg. Electrical examination showed that all of the muscles responded slightly except the tibialis anticus and the extensor proprius pollicis, which appeared to be totally inert. Daily electrical applications were made. It was only at the end of five months that slight contractions were observed in the tibialis anticus. This muscle gradually developed until voluntary control was fairly well established. The foot could be flexed, but the muscle has never become what could be called strong. The electrical applications were continued almost daily to the extensor proprius pollicis for nearly eleven months, but without obtaining the slightest evidence of reaction.

These three cases show that in some instances it is possible to restore, or at least to partially restore, vitality to muscles which were at first regarded as hopelessly degenerated. Because the senses were not able to appreciate minute muscular contractions, there was no proof that such contractions did not occur. They probably did occur. Those muscles which, after months of careful attention, showed visible signs of vitality were probably in relation with cells in an extremely degenerated condition, but which were not completely destroyed, and which, under stimulation, were capable of a certain degree of regeneration. Those muscles which, even after many months of assiduous applications, still failed to show evidences of vitality were evidently completely degenerated and their cells obliterated. These cases simply demonstrate that our senses are not sufficiently acute to determine whether totally paralyzed muscles are capable of improvement or not, and that it is only after long-continued treatment that this point can be definitely ascertained.

NERVE SUTURE AND NERVE BULBS.

H. W. Paget, in "Practitioner," August, 1892. In the brief paper with the above title, the author impresses the well-known fact that the suture of divided nerves fails whenever there is suppuration in a wound. He likewise draws attention to the fact that bulbous enlargements of divided nerves after amputation have become very uncommon since healing without suppuration has been brought about by the aseptic *régime* of the present day. In other words, the avoidance of suppuration has prevented the formation of bulbs at the ends of divided nerves by preventing the conditions under which they occurred.

Few greater boons have indeed been wrought by aseptic surgery than the abolition of this source of pain and discomfort after amputation. J. C.

ciate minute muscular contractions, there was no proof that such contractions did not occur. They probably did occur. Those muscles which, after months of careful attention, showed visible signs of vitality were probably in relation with cells in an extremely degenerated condition, but which were not completely destroyed, and which, under stimulation, were capable of a certain degree of regeneration. Those muscles which, even after many months of assiduous applications, still failed to show evidences of vitality were evidently completely degenerated and their cells obliterated. These cases simply demonstrate that our senses are not sufficiently acute to determine whether totally paralyzed muscles are capable of improvement or not, and that it is only after long-continued treatment that this point can be definitely ascertained.

NERVE SUTURE AND NERVE BULBS.

H. W. Paget, in "Practitioner," August, 1892. In the brief paper with the above title, the author impresses the well-known fact that the suture of divided nerves fails whenever there is suppuration in a wound. He likewise draws attention to the fact that bulbous enlargements of divided nerves after amputation have become very uncommon since healing without suppuration has been brought about by the aseptic *régime* of the present day. In other words, the avoidance of suppuration has prevented the formation of bulbs at the ends of divided nerves by preventing the conditions under which they occurred.

Few greater boons have indeed been wrought by aseptic surgery than the abolition of this source of pain and discomfort after amputation. J. C.